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Structure of Security Elements Effective by Optical Diffraction and Apparatus for Examining Such Elements

The invention relates to the structure of security elements effective by optical diffraction and to an apparatus for examining such elements.

Hitherto, documents with security elements effective by optical diffraction, in particular holograms, are controlled by complex optical testing technology. In such a process the test object must be positioned with great precision. The entire examination process takes so much time that such examination methods cannot be applied in fast-moving processing machines. It is not possible to examine documents provided, for instance, with so-called optically variable devices (OVD) within a document processing machine because it is operating at high speed. In U.S. patent 4,255,652 there is described an apparatus for detecting identification indicia in documents provided with electrically conductive areas. An electric charge is transmitted to one of the electrically conductive areas by means of a first capacitive element extending across and arranged over with width of the document. As the document to be examined is moved further, the charged electrically conductive moves under a second capacitive element extending across the with of the document to be examined, by means of which the charge is withdrawn. An evaluation and decoding circuit will then generate a typical signal function.

This apparatus and its applied functional principle are based upon relatively large electrically conductive areas extending across the width of the document to be examined as the size of the transported charge strongly diminishes with smaller surfaces. A simultaneous examination of several conductive areas is as impossible as it is to define their geometric shape and size. This is particularly true of designs with delicate members.

Furthermore, European patent 0,097,570 proposes a device for

examining the dielectric properties of sheet-like materials, in which the material to be examined is guided between contact pairs of a series of capacitors of a certain configuration. A change in the dielectric properties leads to a change in the voltage at the receiving electrodes. The signals are individually amplified and evaluated.

In this device which relates to the examination of the dielectric properties of the sheet material, in particular of water marks, the oscillator frequency is simultaneously fed to all capacitors which may result in coupling between adjacent channels. Increasing the spacing between the capacitors to prevent this deficiency reduces the attainable geometric resolution. Hence, only coarse structures can be recognized. For controlling problems of transient oscillations at the receiving contacts of the capacitors, only a relatively low switching frequency is permissible which leads to low limits as to the speed of examination. For structural reasons, such a device can also not be used in quickly-running processing machines. In European patent 0,338,378 there is described a combined process for printing and forming a holograms with the reflection material being applied either to the hologram only or also to the surrounding material. The material outside of the hologram is either removed by etching or, to prevent damage to the support layer, it is left on the support layer.

German patent DE 27 47 156 describes a method and a testing apparatus for examining the genuineness of holographically secured identity cards. The OVD is reproduced and a visual control is executed. This process is unsuited for an examination which is quick and efficient and which can be performed independently of personal intervention. European patent EP 0,042,946 describes an apparatus for the generation of scanning patterns which are examined by laser, mirror and lens systems as well as a photo-detector. In this case, too, the economic complexity is very high. It increases even more where the material to be examined is to be tested in an unsorted state. To prevent pre-sorting, a multiple arrangement of the authenticity testing system would be necessary. Demetallizations in security elements effective by optical diffraction have also become known for achieving optical

effects which have hitherto been examined only by optical methods. As is known from U.S. patents 5,248,544 and 5,388,862 optically variable security elements such as holograms mentioned previously and security threads are provided with of metal layers. In holograms, the metal layers serve for reflection, and the security threads appear opaque in penetrating light. Phase-shifted patterns of lightness will be recognized in penetrating light of metallized and demetallized areas in a beam or meandering pattern.

It is the task of the invention to eliminate the disadvantages of the state of the art and to propose a structure of security elements effective by optical diffraction, particularly OVD's, holograms or kinegrams, which may be examined quickly, without human intervention and with insignificant effort. Furthermore, it is a task of the invention to propose an apparatus for examining documents containing such security elements. The apparatus is to be used in document processing machines as well as is manual testing apparatus for examining document provided with security elements effective by optical diffraction.

These tasks are accomplished by the invention hereinafter described.

The use of holograms and other security elements effective by optical diffraction for making certificates and other securities as well as banknotes secure against counterfeiting are currently ever more prevalent. Such documents are, for instance, the 1997 series of German marks which in addition to electrically conductive security strips possess a security element effective by optical diffraction formed by a kinegram. The capability of quick examination represents a further security stage in the evaluation of the elements effective by optical diffraction as a mark of genuineness. Elements which are effective by optical diffraction are made up of a metallized layer, among other things. This metallization layer is electrically conductive. The electrical conductivity changes in accordance with the layer thickness. In accordance with the invention, the element effective by optical diffraction is provided with a discontinuous metallization layer and/or partially metallized layers and/or zone of metallized layers in different planes which represent a

target-oriented electrical encoding of data. The shape of the encoding resembles geometric figures, more particularly lines, grid-lines, bows and/or circles arranged orderly as well as at random. A partially metallized layer arranged above the support layer contains several demetallized segments. A discontinuous metallization layer contains segments of different electrical conductivity.

The apparatus is provided with a capacitively operating scanner. This scanner consists of a plurality of transmitting electrodes in a side by side arrangement and receiving electrodes disposed in parallel thereto. The scanner is disposed within a document processing machine such that the optical and mechanical sensors present in conventional document processing machines will activate the examining device in accordance with the invention. A sensor support is preferably used for reducing detection and measurement errors. This sensor support receives all examination sensors. In this manner, the spacings between the sensors are minimized and the sensors are always arranged in a defined position. Energizing of the individual transmitting electrodes by electric energy takes place in timed intervals by means of an energizing electronic having a switching frequency in the kHz-range. Aside from the current supply the energizing electronic circuit contains as main components a multiplexer, an oscillator for providing energy for the transmitting electrodes and an oscillator for energizing the multiplexer.

When there is electrical conductivity, the energy of any energized electrode is capacitively coupled between the transmitting electrode and a receiving electrode. If no electrically conductive material is present, there will be no transfer of energy between the energized transmitting electrode and the receiving electrode. The signal pattern at the receiving electrode is converted into a corresponding signal image. The signal image is dependent upon the structure of the metallized layer of the optically effective diffraction element. If the optically effective diffraction elements are provided with a discontinuous metallization layer, several segments of the metallization layer will be of

differing electrical conductivities. An electronic evaluation circuit at the output of the receiving electrode compares the signal image of the test object against appropriate reference signals. The electronic evaluation in essence consists of a current source, an amplifier, a demodulator, a comparator, a micro-processor having a memory as well as filters for suppressing extraneous and interference signals.

Aside from the software for the micro-processor there are stored in the memory reference signal images which are compared against the signal image of the document being examined. Since the scanner extends across the entire width of the document every electrically conductive characteristic will be detected by the apparatus in accordance with the invention. The comparison against the reference signal image generates a classifying signal for further processing. Accordingly, a document detected as a forgery, for instance, could be removed by stopping the examining apparatus. The reduce interference the sensor support is connected to a platen for supporting the electronic energizing and evaluating circuits.

The entire test apparatus is provided within a document processing machine so that the need for space may be kept relatively small. The transmitting and receiving electrodes are arranged above and below the documents in the document processing machine such that scanning is positively ensured. This may be accomplished, for instance, by means of belts or within range of deflecting devices so that during transport the document is pressed against the transmitting and receiving electrodes.

In an alternate electrode arrangement it is within the ambit of the invention to position an elongate transmitting electrode in parallel to a linear array of a plurality of receiving electrodes arranged in a side by side relationship. In this case, received signals are processed by means of multiplexers. The remaining electronic evaluation circuit corresponds to the one already described. A further embodiment of the transmitting and receiving electrodes is characterized by a plurality of transmitting and receiving electrodes arranged in side by side relationship and/or in a row.

Energization as well as reception of the signals are processed by multiplexing and demultiplexing methods, as the case may be.

When used in manual apparatus, they are analogously equipped with means for transporting the document or the scanner the function of which is similar to the feeding devices of copying machines, optical image insertion scanners or facsimile machines.

In an alternative embodiment, there is provided a device which defines the position of the capacitively operating scanner of a test apparatus in accordance with the invention relative to the document by means of abutment elements. In this case the document is examined only in the area of the transmitting and receiving electrodes.

The characteristics of the invention are apparent not only from the claims but also from the specification and the drawings, whereby individual characteristics may define advantageous patentable embodiments either by themselves or with others as sub-combinations, for which protection is applied for here. Embodiments of the invention are depicted in the drawings and will be described in greater detail hereinafter.

In the drawings:

Fig. 1 is a schematic presentation of a document with an OVD and meandering demetallized layers;

Fig. 2 is a schematic presentation of a document with an OVD and strip-shaped demetallized layers;

Fig. 3 is a schematic presentation of a document with an OVD and strip-shaped demetallized layers;

Fig. 4 is a schematic presentation of a document with an OVD and grid-shaped demetallized layers;

Fig. 5 is a schematic presentation of a document with an OVD and

several security elements;

Fig. 6 is a block circuit diagram of a testing apparatus;

Fig. 7 is a schematic presentation of the scanner with a plurality of transmitting and receiving electrodes;

Fig. 8 is a schematic presentation of the scanner with one transmitting electrode and a plurality of receiving electrodes;

Fig. 9 is a schematic presentation of the scanner with a plurality of transmitting and receiving electrodes;

Fig. 10 is a schematic presentation in side elevation of the scanner and a document to be examined;

Fig. 11 is a schematic section of an OVD with demetallized segments;

Fig. 12 is a voltage - time diagram of the evaluation signal;

Fig. 13 is a schematic section of an OVD with a discontinuous metallization layer;

Fig. 14 is a voltage - time diagram of the evaluation signal.

The examples of Figs. 1 - 5 depict documents provided with security elements in accordance with the invention, all of which contain target-oriented electrical encoding. The encoding is not carried out as an encryption of any kind of data but rather electrically conductive examination indicia are set up in a target-oriented manner by an arrangement of electrically conductive structures relative to each separated by non-conductive structures, the electrical encoding of which will generate a predetermined signal pattern by means of the test apparatus in accordance with the invention, the signal pattern being compared to an established stored reference signal pattern. This results in the intended high test speed. The capacitively operating scanner of the apparatus in accordance with the invention has also been schematically shown.

Fig. 1 presents the schematic structure of an OVD 1 provided with a metallization layer 2. The metallization layer 2 has a demetallized zone 3. When seen in top elevation view, the demetallized zone 3 is of meandering configuration. The width of the meander-shaped demetallized zone is greater

than the smallest distance between two electrodes. The capacitively operating scanner consists of a plurality of transmitting electrodes 5 arranged in side by side relationship and a receiving electrode 6 disposed in parallel to this linear array.

Fig. 2 depicts the schematic structure of an OVD in which alternating metallized and demetallized strip-shaped zone 7 are disposed in parallel to each other. The zones 7,8 which in top elevation are of strip-like configuration may extend parallel to or normal to the document feed direction. The latter arrangement is depicted in Fig. 3. The distance between two zones of the same electrical conductivity is between .2 and 1.0 mm. The widths of the zones of the same electrical conductivity are varying.

The combination of the characteristics of the examples 2 and 3 is depicted in Fig. 4. Alternating metallized strip-like zones 7 and demetallized strip-like zones are disposed parallel to the document feed direction. The metallized zones 7 are interrupted by a strip-like demetallized zone 9 extending vertically thereto.

Fig. 5 depicts a document provided with several OVD. The deliberate combination of optically effective diffraction elements results in further encoding. The accuracy of the examinations is increased thereby.

Figs. 6 - 9 depict the block circuit diagram as well as different embodiments of the capacitively operating scanner 4.

Fig. 6 depicts the block circuit diagram of a test apparatus in accordance with the invention, consisting of an electronic energizing circuit, a capacitively operating scanner 4 and an electronic evaluation circuit. Aside from the current source, the electronic energizing circuit essentially consists of a demultiplexer 10, an oscillator 11 for providing energy for the transmitting electrodes and an oscillator 12 for energizing the demultiplexer.

The electronic evaluation circuit essentially consists of a current source, an amplifier 13, a demodulator 14, a comparator 15, a micro-processor 16 provided with a memory and filters for the suppression of extraneous and interference signals.

Cast into a sensor support are the transmitting and receiving

electrodes. These form a capacitively operating scanner 4 extending across the entire document feed width. The strip-shaped receiving electrode extends transversely of the document feed direction. The transmitting electrodes are arranged in parallel to the receiving electrode. The distance of a transmitting electrode to the receiving electrode is conditioned upon electrically conductive examination characteristics typical of the document. Placing several transmitting electrodes in a linear array makes it possible in the longitudinal axis of the capacitively operating scanner 4 to detect several electrically conductive characteristics at the same time. The resolution attainable by this arrangement depends upon the number of the applied transmitting electrodes. In the present embodiment the resolution at one scannable point per mm extends in both the longitudinal and transverse directions.

The minimum spacing between neighboring transmitting electrodes is limited by the interfering capacitive coupling among the electrodes. To prevent it and to reduce interference of neighboring electrodes, the transmitting electrodes are sequentially energized by a multiplexer 10. The documents are being examined independent of their disposition as a result of the transmitting electrodes being arranged across the entire width of the document fee direction. Accordingly, pre-sorting of several documents in a document processing machine may be dispensed with.

Fig. 7 is a schematic rendition of the scanner 4 provided with a plurality of transmitting electrodes 5 and one receiving antenna 6. Energization and evaluation are performed by circuit of the block diagram of Fig. 6.

Fig. 8 is a schematic presentation of an embodiment of the capacitively operating scanner provided with one transmitting electrode 17 and a plurality of receiving electrodes 18. In a manner different from the block circuit diagram of Fig. 6, the transmitting electrode 17 is energized by an oscillator. The signals of the receiving electrodes 18 are processed by a multiplexer. The additional electronic evaluation circuit consisting of a current supply, an amplifier, a demodulator, a comparator, a micro-processor provided with a memory as well as filters for the suppression of extraneous and interference signals is the same as in Fig. 6.

Fig. 9 is a schematic presentation of a further embodiment of the capacitively operating scanner provided with a plurality of transmitting electrodes 19 and a plurality of receiving electrodes 20. There alternatingly arranged in a linear array. Accordingly, the energizing signals of the transmitting electrodes 19 as well as the evaluation signals of the receiving electrodes 20 are processed by multiplexing and demultiplexing processes.

Fig. 10 is a schematic presentation in side elevation of the capacitively operating scanner 4 and a document to be examined. The OVD consists of partial metallizations 21 as well as of an electrically insulating support foil 22.

Fig. 11 depicts a schematic sectional view of an OVD consisting of a support layer 23 and a partially metallized layer 24. The partially metallized layer 24 consists of several demetallized segments 25. Fig. 12 presents the associated evaluation signal in a voltage - time diagram.

Fig. 13 is a schematic sectional view of an OVD consisting of a support foil 26 and a discontinuous metallization layer 27. The discontinuous metallization layer 27 is provided with segments 28, 29, 30, 31, 32 of different electrical conductivity. Fig. 14 shows the associated evaluation signal in a voltage - time diagram.

In the context of the present invention, the structure of optically effective diffraction elements and an apparatus for examining such elements have been described on the basis of concrete embodiments. It is to be noted, however, that the present invention is not limited by the details of the description of the embodiments as changes and variances are being claimed within the scope of the claims. Accordingly, in addition to optically effective diffraction elements other electrically conductive characteristics may also be detected. The deliberate combination of optically effective diffraction elements with other electrically conductive characteristics results in further encoding. At the same time, further electrically conductive test characteristics such as, for example, an electrically conductive security strip or encodings made of electrically conductive dye may be classified by the examining apparatus according to the invention.